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Situations and problems of renewable energy in the Region of Murcia, Spain

M. Dolores Gómez-López *, M. Socorro García-Cascales, Eduardo Ruiz-Delgado

Group of Management and Aid Decision Support in Project Engineering, Technical University of Cartagena, Paseo Alfonso XIII 48, 30203 Cartagena, Spain

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ABSTRACT

Renewable energies in Spain have been promoted since 2002, proof of this lies in the fact that in 2007 renewable energy accounted for 6.9% of the consumption of primary energy. The renewable energies market is one of the sectors with the greatest growth in recent years in Spain and is key to the energy policies at national level.

Both at national and regional level diverse targets have been set for the production of renewable energies, this article seeks to analyse the potential, current state, and perspectives of renewable energies in the Region of Murcia, investigating the possibilities of fulfilling the objectives established.

The solar energy potential should be highlighted, where most of the territory has more than 5.0 kWh/m^2; also the wind power potential, where in certain areas there are winds of more than 6 m/s; and the biogas potential due to the extensive livestock herds. With reference to the targets for photovoltaic and wind power, these have been reached; but in the rest of the energy sources the fulfilment of the objectives depends on favourable management and administration policies.

Likewise, a comparative study of the state of the Region of Murcia has also been carried out, taking the national situation as the reference.

Contents

1. Introduction

The generation of energy in Spain presents the distribution reflected in Fig. 1. It can be seen that in 2007 renewable energies (RE) accounted for 6.9% of the primary energy consumption including the large hydro-electric, compared to the target of 12% for 2010 [1].

Although renewable energy sources have been promoted in Spain since before 2002, the percentage of the total has not increased significantly since then. The growth rate of the demand is greater and the increase in installed capacity in renewable energies does little to compensate this.

* Corresponding author. Tel.: +34 968 325 668; fax: +34 968 325 732.
E-mail address: lola.gomez@upct.es (M.D. Gómez-López).

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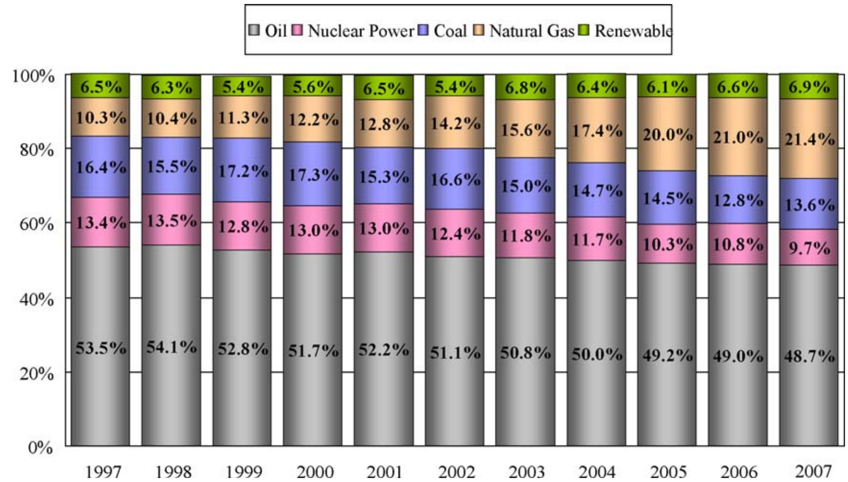


Fig. 1. Evolution of the contribution of the different energies on total consumption in Spain. *Source:* National Energy Commission.

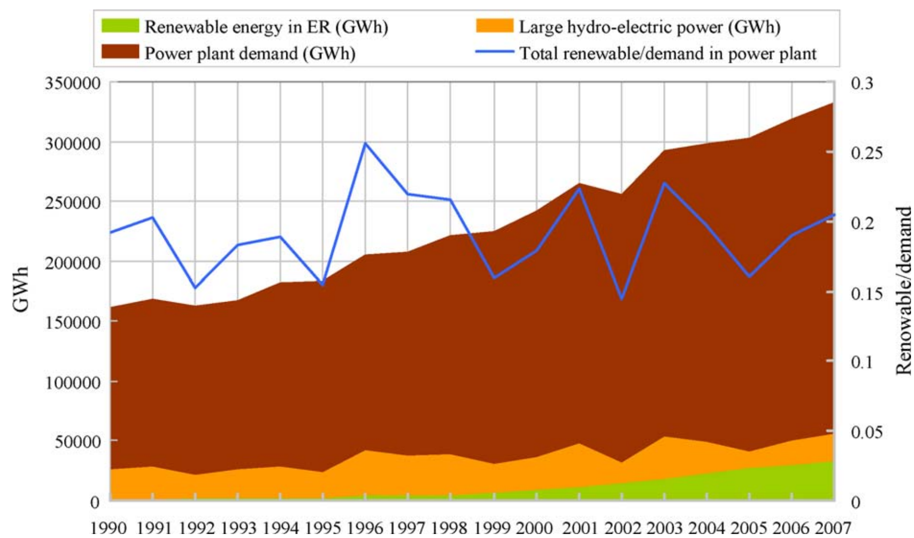


Fig. 2. Evolution of the participation of renewable energies in the electricity demand at busbars. *Source:* National Energy Commission.

In spite of this fact, the participation of renewable energies in the electricity demand at busbars is significant (Fig. 2); this being understood as the energy introduced into the grid from ordinary and special regime power stations, plus the balance of international exchanges.

The sales of electricity coming from renewable energies in 2007, taking into account the large hydro-electric, totalled 20% of the gross electricity demand, as can be seen in Fig. 2, with the Community target of attaining a participation of renewable energy sources of 29.4% in Spain in the electricity consumption for the year 2010 [2].

The generation of electrical energy in Spain is regulated by law. The renewable energies could not at present compete with the conventional power stations in terms of cost per kW in the market, as can be seen from Table 1. If we analyse the data in depth we can see that the lowest availability time (fraction of time taken over the total to be able to enter the energy generated into the grid), is for solar energy, closely followed by wind power. For this reason, when the cost per kilowatt is adjusted with that availability, then the values of the cost of the installed capacity increase appreciably for these technologies. It is calculated that this differential of the cost could be compensated in the medium term by the reduction in the generation cost enabled by the improved technologies in renewable energy. Meanwhile, a legislative framework is needed to assure the development and competitiveness of the renewable energies. In Spain this competitiveness is based on a system of production bonuses.

There are many aspects to be taken into account when we speak of the current situation of RE in the Region of Murcia [4], located in the southwest of Spain. One of the aspects and perhaps the most important is the potential of the region in this field, it should not be forgotten that the principal source of RE is nature itself and therefore it is something that has already been given. From this perspective it shall be shown that not all RE present in the region lend themselves to extensive exploitation. This will serve to establish the logical base onto which the region evolves in this field.

The article is organised as follows: in Section 2, we shall analyse the capacity of the RE in the Region of Murcia. Subsequently, in Section 3 the degree of implantation of the energies with the greatest presence in the Region of Murcia will be described. Section 4 presents a comparative of the Region of Murcia with respect to the rest of Spain; and finally the most important conclusions are detailed.

Table 1
Comparative of energy generation costs.

	Geothermal	Gasified waste	Solar energy	Coal	Wind power	Natural gas combined-cycle	Gasified coal
Energy availability (%)	80	85	30	85	31	85	40
Cost kW installed ($)	1415	1333	4083	1000	742	463	1300
Set to availability ($)	1769	1568	13610	1176	2394	545	3250
Operating cost/kW ($)	0.009	0.011	0.005	0.015	0.009	0.021	0.015
Set to availability ($)	0.011	0.013	0.015	0.018	0.030	0.024	0.038

Source: UBS Warburg [3].

2. Potential of renewable energies in the Region of Murcia

2.1. Energy potential

The energy potential in the field of RE is that brought about by natural resources, thus so it is that not all these energy sources, as is logical, are equally possible in the Region of Murcia, due to differences in the source resources. Therefore we shall talk about the resources themselves and the energies which will be served by them.

2.2. Solar potential

It goes without saying that if Spain has something, then that something is sun, and in the Region of Murcia even more so. Documentary proof of that is the Solar Radiation and Atmospheric Temperature Atlas of the Autonomous Community of the Region of Murcia [5], which shows that the majority of its territory has more than 5.0 kWh/m^2 (Fig. 3).

In the report "The role of photovoltaic generation in Spain" [6], it is affirmed that with only 1.1% of the surface area of the Spanish territory the total demand for energy could be covered. That is to say, that with much less than half of the surface area of the Region of Murcia the whole demand in Spain would be satisfied for that year.

It must be taken into account that the exploitation of this potential requires surface area, so the surface available is a factor to consider, understanding within this concept the availability of the land as well as its qualification. The urban planning for the different municipalities of the Region of Murcia, and according to the Land Law, is where the use for each area of land is defined. According to these regulations, the installations of photovoltaic and solar thermal energy can be located on industrial land and on non-building land which fulfil the Directives and Territorial Planning for Industrial Land [7]. It should be pointed out that in the case of low-temperature thermal energy, its installation is annexed to buildings and therefore the classification of the land is not prescribed.

Obviously to ensure that this energy is usable in the night time hours, an adequate storage system must exist which is capable of accumulating this energy efficiently. Although we may be prepared to utilise the batteries necessary to achieve this, the contaminant potential and the additional cost that this would suppose for the electricity tariff should not be forgotten. The proximity of these evacuation grids is also an important limiting factor since it influences directly on the installation costs and therefore negatively affects the profitability of these installations.

2.3. Wind power potential

The wind power potential of a good part of the Region of Murcia is reflected in the elaboration of the wind power study commissioned by the General Direction of Industry, Energy and Mines and carried out by the Institute for Diversification and Energy Saving (IDAE) in 1996 [8]; and a study of wind power potential in the Region was carried out in 1999 by the Regional Ministry for Agriculture, Water and the Environment, and the Centre for Energy, Environmental and Technological Investigations (CIEMAT) [9]. The results of this latter study indicate that there are diverse zones in the region where the winds exceed mean speeds of 6 m/s.

Fig. 4 shows three clearly distinct zones of potential wind power in the Region of Murcia: the highland area, the northwest, and the coast.

To obtain the wind power potential in terms of energy it is necessary to consider an aerogenerator technology and a density of installed capacity in each zone. This allows a figure in megawatts (MW) to be obtained. The values considered in this article as the

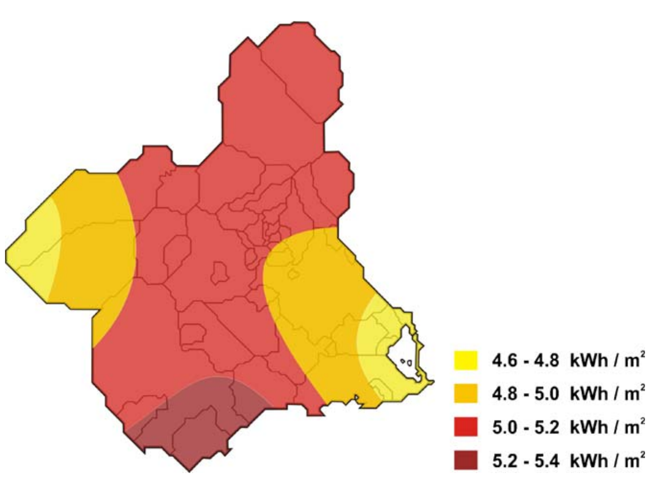


Fig. 3. Mean values of global daily radiation expressed in kWh/m^2. *Source:* National Meteorological Institute.

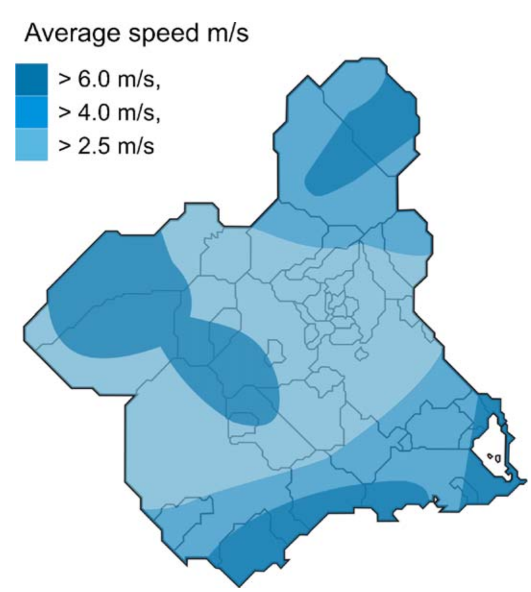


Fig. 4. Map of wind power potential in the Region of Murcia. *Source:* ARGEM, Regional Ministry for Agriculture, Water and the Environment and CIEMAT.

Table 2
Previsions of exploitation in wind power energy in the Region of Murcia.

Wind zone	Potential 2012 (MW)
Highland area	350
Northwest area	350
Coast and rest of the Region	150
Total	850

Source: ARGEM.

potential are the forecasts for exploitation of wind energy for the year 2012 [10] shown in Table 2.

Despite the great potential of the coastal zone, the exploitable energy is far less than in the northwest due to the limitation of space which the high level of urban and residential occupation of these zones.

The prevision for 2012 in the coastal zone could be greater if the study considered marine wind power. According to the Report of Environmental Sustainability and Environment Strategic Study of the Spanish Coast for the installation of marine wind farms [11], in the Region of Murcia, interferences have been found which could occur between the marine wind power and the fish reserves and the underwater archaeological heritage. This, coupled with other aspects including underwater and visual environmental impacts, being close to maritime routes, and the depth of the sea-bed on the coastal platforms make this a technology not to be considered at present in the Region of Murcia.

2.4. Biomass potential

The exploitation of this kind of energy, according to the draft of the Energy Plan for the Region of Murcia [10] is currently only from natural vegetable biomass, which is utilised above all in the form of firewood.

In any case, taking into account the characteristics of the Region of Murcia, the exploitable potential is conditioned by the surface area being cultivated and by the forestry and agricultural waste. With regard to agricultural waste, given the eminently agricultural character of the Region, it supposes one of the greatest potentials in renewable energies, since in 2007, there were 109554 hectares of arable crops, 210894 hectares of woody crops and 276894 hectares of forest land [12]. Proof of the potential of the crops is presented in the map of potential distributions of agricultural waste, as shown in Fig. 5.

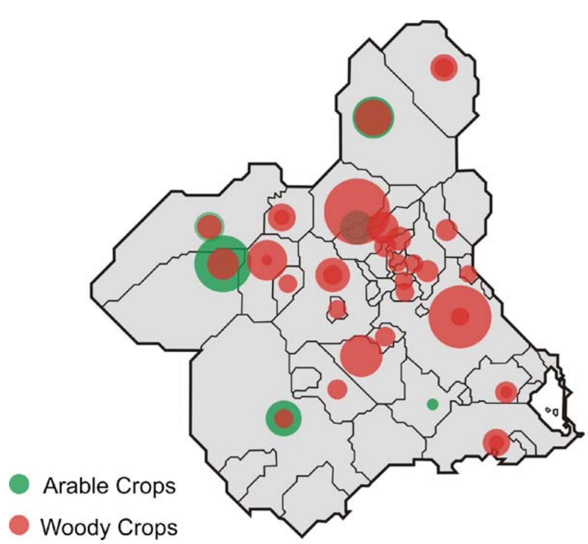


Fig. 5. Map of the potential distribution for biomass in the Region of Murcia. *Source:* ARGEM.

Table 3
Potential energy from biomass in the Region of Murcia.

Types of biomass	Power (toe)
Woody crops	82249
Arable crops	21210
Forest biomass	39872
Total	143331

Source: Own production from conversion data from the IDAE (2007).

As can be appreciated, the distribution of this resource in the total surface area of the region is quite heterogeneous. If we consider the sources mentioned, then the possible exploitable potential of the Region of Murcia in energy obtained from biomass in 2007 is summarised in Table 3.

As we can see, a total of 143331 toe (tonnes of oil equivalent) could be obtained from this resource, a value similar to that marked for the Region of Murcia in the Renewable Energies Plan, PER 2005–2010 (140501 toe) [1], so it is possible to state that the target is somewhat ambitious, since it considers processing 98% of the biomass generated.

It should be pointed out that the target for biomass is difficult to achieve because its development poses numerous obstacles, clear problems are the technologies to exploit it, decentralising production and the uncertainty of the supply, which makes it not a widely organised sector and not a particularly profitable one, above all in the Region of Murcia.

2.5. Biogas potential

The waste which is normally used for the production of biogas, and which is available in the region, in some cases in great quantity, is that generated in the controlled tips for municipal solid waste (MSW); the sewage sludge from urban wastewater treatment plants; biodegradable waste from the food industry; and livestock waste.

If we consider the current official data, for each of these types of waste we can calculate what its production of biogas would be, taking into account that the future potential of this resource is conditioned by the growth of the waste and by the degree to which it is treated.

It should be highlighted out that for each of these sources its yield should be utilised in the conversion to biogas. In [9,13], values for the yield in conversion to biogas can be found for different sources (Table 4), and given their dispersion, we will subsequently take mean values, in each case.

If we focus on the MSW, we see that in 2005 the generation of this type of waste according to the Murcia Regional Statistics Centre, was of 478 kg/capita/year. Thus, if we take the population of the Region of Murcia in 2007 (1392117 inhabitants), we then have a figure of 665432 t of MSW generated per year in the region. If all these wastes were managed in controlled tips and biogas was obtained from it, it would be equivalent to the generation of 103.44 GWh.

With sewage sludge we see in a similar way that in 2007 in the region 295485 m^3/day of controlled wastewater was produced in

Table 4
Yield values in terms of biogas for the different wastes.

Waste	Biogas (m^3/t)
MSW	48–144[(1)]
Sewage sludge	85–110[(1)]
Industrial waste	90–256[(1)]
Pig slurry	165–320[(1)]
Chicken droppings	130–200[(1)]
Cattle, sheep and goat manure	150[(2)]

Source: [(1)][13]; [(2)][9].

Table 5
Production of biogas from livestock waste.

Livestock species	Number	t manure/year	toe/year
Cattle	78798	534598	32075
Sheep	643333	312199	18732
Goat	201025	92097	5526
Pig	2055883	3892840	423930
Chicken	389928	14233	1056
Total			481319

Source: Own production from data from [11] and ARGEM.

the wastewater treatment plants. As in the case of the MSW, if all were treated and exploitable, then 45.28 GWh could be obtained from this waste.

The biodegradable food industry waste is difficult to quantify, although the data from the Murcia Regional Statistics Centre are available [11]; it can be seen that for 2007, the volume of waste generated in the food industry which could be exploited for biogas is catalogued as animal and vegetable waste and totals 82984 t, which constitutes a value of 23.49 GWh. It must be pointed out that to date the exploitation of this waste, when it occurs, is being carried out within the same industrial process of each company, so it is therefore normally not considered within the global calculation of the energy obtained from this biogas, although, as shall be seen, its management would be rather interesting.

Table 5 presents the data for the production of biogas from livestock waste, with data taken from the last official census of livestock heads in the region [11], from 2007.

The sum of these quantities corresponds to a total of 1750 GWh per year.

If all these sources were considered together then the potential in biogas in the Region of Murcia would be 1922.2 GWh. As can be appreciated, almost 90% of this quantity could be obtained from the livestock waste, since the region has extensive livestock herds, with above all the possibility that 84% of the total would be provided by pig slurry. The PER 2005–2010 [1] shows that the target laid down for the Region of Murcia was of 40274 toe (approximately 148 GWh), which as can be seen, would be largely exceeded.

2.6. Potential in biofuels

The specific objectives for Murcia in terms of the production of biofuels according to the PER 2005–2010 [1] are of 220000 toe for 2010. The actual figure for 2004 was of 51200 toe. This production proceeds from the plant of Ecocarburantes Españoles, a pioneering installation in Spain in the production of bio-ethanol. The current capacity of the plant is of 100000 t/year of bio-ethanol. To be able to reach the figure assigned it is necessary to create further plants. There is currently a plant projected in the Valle de Escombreras (Cartagena, Murcia) of more than 250000 t/year of biodiesel. This plant could be what is needed to reach the values of the 2010 target.

The production of biofuels in the European Union is seeing high growth rates. However, the present tendency is insufficient to fulfil the energy targets established [14].

The directive 2003/30/CE [15], related to the promotion of the use of biofuels and other renewable fuels in transport, establishes the target of reaching a market share in the transport sector of 5.75% in 2010 and the directive 2003/96/CE [16] includes the possibility of extending a reduction or exemption in taxation for the biofuel produced in industrial projects. These two directives are expected in the coming years to boost the development of biofuels by promoting their use and modifying their fiscal situation.

The consumption of biofuels in Spain at the end of 2004 was 228.2 ktoe [14]. The relevance of these data is the fact that, until the year 2000, there was no biofuel production plant in operation, whilst at the end of 2004 Spain had become European leader in the production of bio-ethanol and had made rapid advances in the sector of biodiesel. By the end of 2004 production had reached 46% of the energy target which had been set in the Plan for the Promotion of Renewable Energies PFER (2000–2010) [17].

With regard to the type of projects developed in Spain, it is possible to say that currently there are production projects in both bio-ethanol and biodiesel. The former are characterised by the use of cereals as the raw material for the process, while in the biodiesel production plants put into operation to date, the raw material is, in all cases, used vegetable oil, merely due to the price of the product.

The Spanish market awaited the coming into force of the order ITC/2877/2008 [18] by which a mechanism is established for the use of biofuels and other renewable combustibles for the purposes of transport, with the obligation of mixing 3.9% of biofuels with the traditional fuels for the year 2010. With the coming into force of this resolution Spain could have excess production of these biofuels. The plants currently in operation could produce 1.4 million tonnes; the plants currently under construction would add a further 3.3 tonnes, making a total of 4.7 million tonnes, which doubles the total needs forecast for 2010. However, despite the coming into force of the above-mentioned obligation, there is a great risk of the European Commission revising the calendar for the progression of biofuels.

The biofuels obtained from seeds and energetic crops such as maize, oilseed rape, sugar cane, cereal, beetroot, soya and sunflower are considered as first generation biofuels. These are what have received the greatest development and production in the world today. Yet these first generation biofuels currently face the following obstacles, according to the report [19]. (A) Despite improvements in the efficiency of the production their "relatively" high cost is a critical barrier to their development. (B) They have a poor image in the media. (C) They may be affecting food prices. (D) They require large quantities of water. (E) They may be promoting deforestation. (F) The FAO has been warning of the reduction in food stocks for some time. (G) The Ecologist NGOs cast shadows over the fight against climate change without adequate safeguards.

Initiatives have been proposed related to the certification of the raw material, the processes and the production systems, as the principal solution to these drawbacks, in this way their origin can be guaranteed. However, there are more detailed analyses which indicate that all the factors which affect the first generation biofuels will produce in the medium term a reduction in the interest for this activity.

There is a second generation of biofuels into which interest is being placed. These are biofuels obtained from lignocellulose. These biofuels may prove to be an alternative. Their advantages according to the CIEMAT are: (1) there are sufficient resources to substitute those derived from oil; (2) the raw materials come from products not linked to the food market; (3) some of them are of waste origin such as the arable waste of the agricultural activity; (4) the prices are very competitive with the products derived from oil. But this technology is still not mature. It is difficult to obtain biofuels from lignocellulose, and there are no commercial plants yet, although at present the CIEMAT is developing a plant to obtain biofuels from lignocellulose biomass.

2.7. Hydro-electric potential

The problems associated with the low rainfall; to the overexploitation of the aquifers; and to the lack of important different levels in the borders of the basins, which characterise the region, lead one to think that this type of source is not especially

Table 6
Hydro-electric energy generation installations in the Region of Murcia in 2007.

Name	Location	Capacity (kW)
HOYA GARCIA	Cieza	583.00
"EL BAYO" HYDR-ELEC. POWER ST.N	Calasparra	1386.00
"EL PERALEJO" HYDR-ELEC. POWER ST.N	Calasparra	1053.00
LA ESPERANZA	Calasparra	1107.00
GUARDA	Totana	676.00
PARTIDOR	Totana	588.00
MOLINOS	Alhama de Murcia	1235.00
MORATALLA	Moratalla	1773.00
MURTA	Moratalla	974.00
BERBERIN HYDRO-ELECTRIC	Calasparra	2334.00
HOYA GARCIA HYDRO-ELECTRIC	Cieza	3310.00
Total		15019.00

Source: Ministry of Industry, Tourism and Commerce.

advisable and even more so when it is compared with other energies in which the potential is greater and exploitation is easier.

Despite all this, several installations of the so-called minihydro-electric installations ($P < 10$ MW) exist, located mainly in irrigation pipelines. These companies as well as their productions for 2007 are presented in Table 6.

Other installations exist which are not operating for diverse reasons and these have an installed capacity of 6200 kW, and their restart is not envisaged.

It must be considered that with other renewable energies existing which are easier to obtain, compliance with the Horizonte 2010 (22 MW), assigned to the Region of Murcia poses difficulties.

2.8. Geothermic potential

According to the General Inventory of Geothermic Manifestations carried out by the Geological and Mining Institute of Spain, (IGME) [20], in the Region of Murcia low-temperature geothermic deposits of great interest have been detected. These are located principally in aquifer structures in the Baetic zone and the tertiary and quaternary basins of the zones of the countryside of Cartagena, Lorca, Guadalentin and Mula. The temperatures registered in these deposits are: 50 °C in the spa of Archena, 46 °C in the aquifer of the Sierra de Carrascoy, 45 °C in the countryside of Cartagena, 45 °C in the spa of Fortuna, 37 °C in the baths of Mula, 41 °C in the baths of Alhama, 30 °C in the aquifer of the Valle del Guadalentin, and 48 °C in the zone of Mazarron (Fig. 6).

The exploitation of the geothermal energy in the Region of Murcia is by far the highest in Spain with 4870 toe exploited [10].

Table 7
Geothermic exploitation in greenhouses in the Region of Murcia.

Location	Capacity (kW)	Surface area (m^2)	Production (toe/year)	Crops
Mazarron	873	80000	601	Pepper
Gea y Truyols	2009	11000	221	Pepper
San Javier	2386	23000	281	Pepper, Flowers
San Javier	2135	23000	230	Pepper
San Javier	1507	12000	133	Pepper
Fuente Alamo	1674	10000	120	Pepper
Fuente Alamo	4814	120000	898	Tomato
Totals			2484	

Source: ARGEM.

Table 8
Geothermal exploitation in spas in the Region of Murcia.

Location	Temperature hot water (°C)	Volume (m^3/day)	Production (toe/year)
Archena	49.7	355	431
Fortuna	44	1494	1516
Baños de Mula	37.3	562	438
Totals			2386

Source: ARGEM.

Table 7 shows the principal installations exploiting this to heat greenhouses. Table 8 shows those installation utilised to exploit this in spas.

Due to the low temperature of the geothermal flows, the applications are limited to the heating of greenhouses on winter days and for the use of hot water in spas. Although there are other industrial applications in the investigation phase, it is too early to speak of other future applications.

The exploitation in this field between 2001 and 2007, as well as the target for 2012 have been extracted from the draft of the Energy Plan for the Region of Murcia [10] and are presented in Table 9.

Although the current production data allow one to infer that the progression is such that the targets will be met, it is necessary to indicate that this type of energy is currently facing obstacles in the applications in greenhouses. Since the waters are very saline, the pipes become blocked by the precipitation of salts when the temperature of the water in circulation through the pipes falls [21].

On the other hand taking into account that the applications do not lend themselves to be an alternative with regard to the generation of electrical energy in the special regime [22], then this energy will not be considered in the section of detailed analysis by technologies.

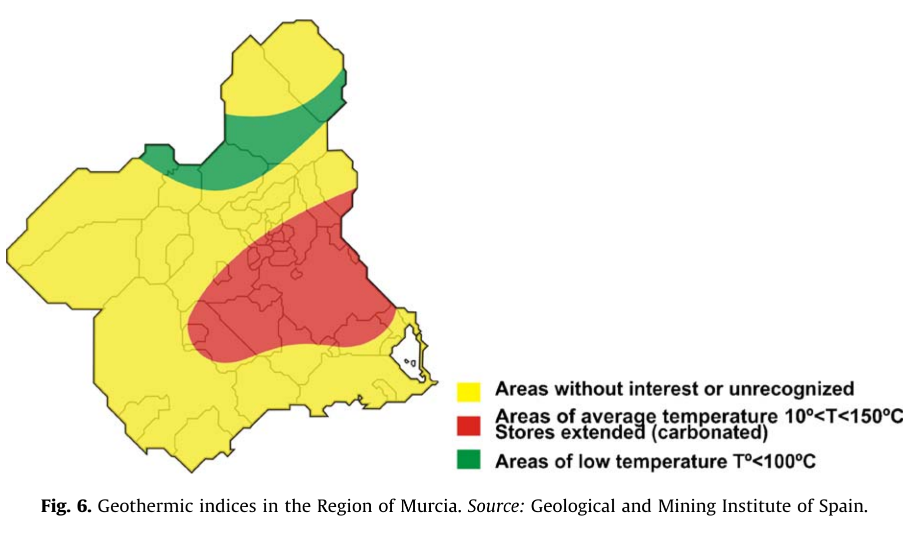


Fig. 6. Geothermic indices in the Region of Murcia. *Source:* Geological and Mining Institute of Spain.

Table 9
Geothermal exploitation between 2001 and 2007 in the Region of Murcia and Target of the Regional Energy Plan 2012.

Year	Production (toe)
2001	2917
2007	4870
2012	6087 (target)

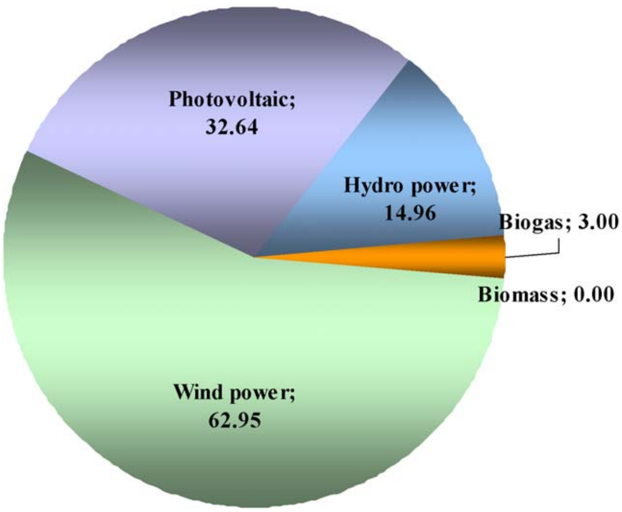


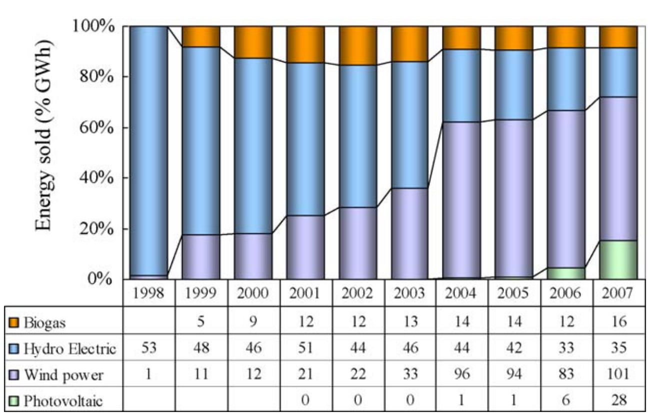
Fig. 7. Total installed capacity, MW in the Region of Murcia for the different renewable energies in 2007. *Note: Considering only legalised files. *Source:* National Energy Commission.

3. State of renewable energies in the Region of Murcia

As can be seen in Fig. 7, the greatest capacities installed in RE in 2007 (considering the installations with all the administrative procedures accepted), are in the fields of solar and wind power. These data coincide with what we have seen in the previous section, since they are also the sources which offer the best prospects in the Region.

As can be appreciated from Fig. 8, the increase in photovoltaic and wind power energies is more pronounced from the years 2002 to 2004. This is clear proof of the positive effect of the law RD 436/2004 [23] which gave precedence to the generation of electrical energy from renewable sources.

On the other hand, hydro-electric energy has been the principal source of renewable energy historically since 1998, but due to the unfavourable water regime and the age of the installations their contribution to the generation of energy has been decreasing over the years.



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Biogas		5	9	12	12	13	14	14	12	16
Hydro Electric	53	48	46	51	44	46	44	42	33	35
Wind power	1	11	12	21	22	33	96	94	83	101
Photovoltaic				0	0	0	1	1	6	28

Fig. 8. Evolution of the energy sold of photovoltaic, wind power, hydro-electric and biogas in the Region of Murcia. Percentage of GWh of the total. *Note: Considering only legalised files. *Source:* National Energy Commission.

4. The situation of renewable energies in the Region of Murcia with respect to Spain

Having reached this point it becomes necessary to locate the Region of Murcia in the context of Spain and to see in what position it finds itself with respect to other regions, as well as to quantify the volume of implantation of each renewable energy over the whole national volume.

In this section we shall deal with only those renewable energies which possess a major generation volume at present or a greater potential in the future, as is the case with solar photovoltaic energy, wind power energy, hydro-electric energy, and biogas. The values presented are those provided as official values by the National Energy Commission [24].

Distinguishing between the differences which motivate businessmen from different regions to implant, to a greater or lesser degree, a technology is conditioned by numerous factors which are difficult to isolate and justify. The network of subsidies, a strong entrepreneurial fabric and of course the natural potential of the resource, are among the determining factors.

If we consult Fig. 9 with regard to the production of energy from photovoltaic installations, the Region of Murcia occupies the eighth position. The percentage of the total for Spain is 6.5%. It is clear that the increase in this energy has been spectacular in the majority of regions. However, some regions have enjoyed a greater boom. Should we take into account the forecasts made in the PER 2005–2010 [1], then the percentages which were assigned of the total are very different to those that the industry has generated. In the case of the Region of Murcia, the PER assigned it 5% of the total and as we can see this has long been exceeded.

With regard to other regions it can be said that as occurs in the Region of Murcia the capacities installed in Castilla La Mancha, Valencia and Navarra have seen increased growth in the last year (data not shown), as a consequence of the policy of energy generation bonuses with renewable sources and changes in the legislation, which has led the entrepreneurs to put forward their investment forecasts.

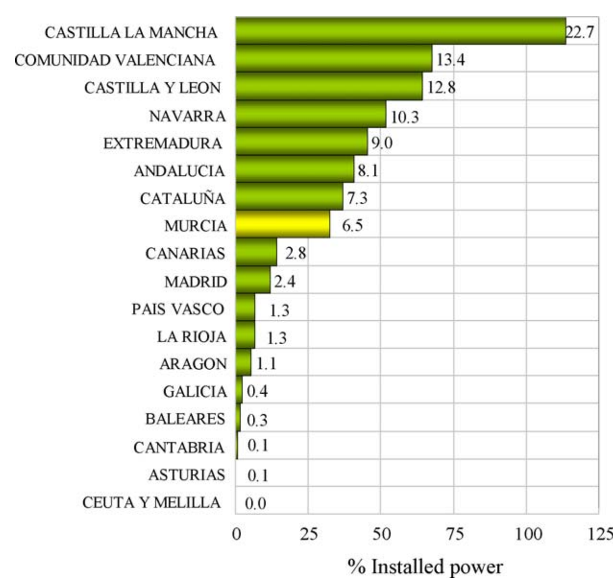


Fig. 9. Installed capacity in solar photovoltaic energy in 2007 by regions. Percentage of the total. *Source:* Own production from data from the Ministry of Industry and CNE.

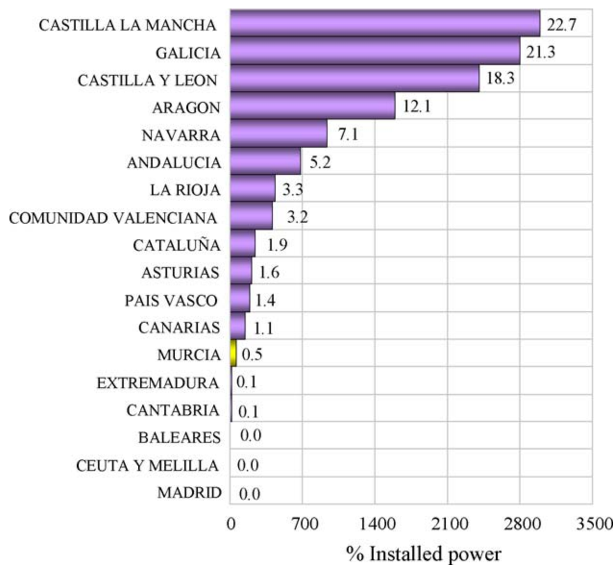


Fig. 10. Installed capacity of wind power in 2007 by regions. Percentage of the total. *Source:* Own production from data of the Ministry of Industry and the NEC.

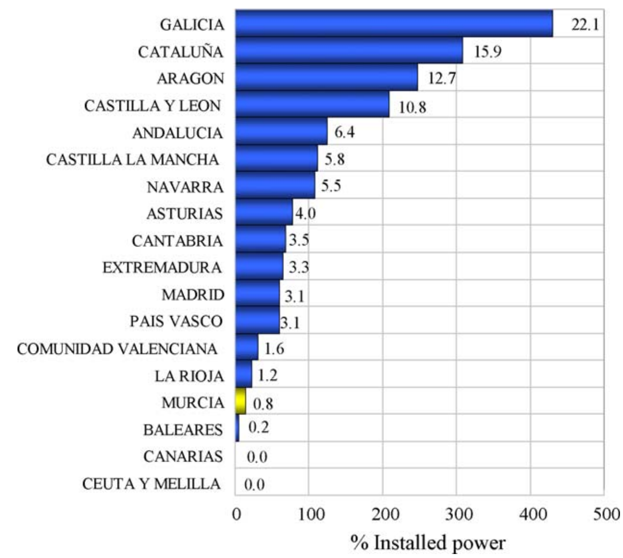


Fig. 11. Capacity installed in hydro-electric energy in 2007 by regions. Percentage of the total. *Source:* Own production from data of the Ministry of Industry and the NEC.

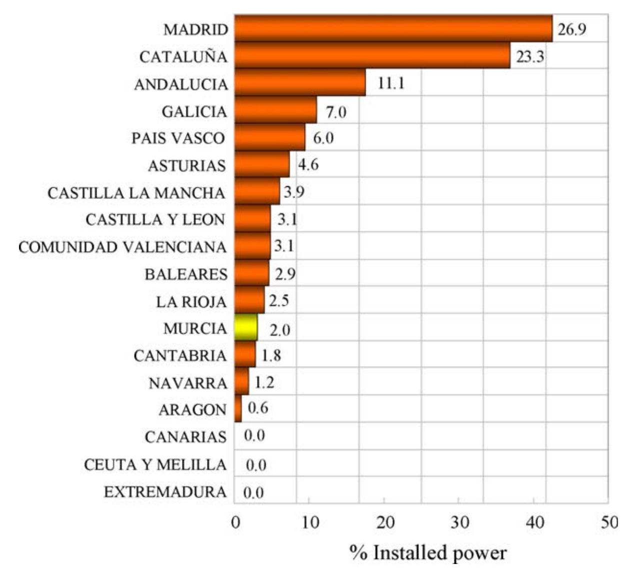


Fig. 12. Power produced from biogas in 2007 by regions. Percentage of the total. *Source:* Own production from data of the Ministry of Industry and the NEC.

As we have commented it is difficult to discern the reasons which motivate the increase in installations, thus we can find for example that in Navarra and Castilla León with medium potentials in solar radiation they have installed capacities superior to those of the Region of Murcia. Consulting the data of the IDAE we can see that in both of these regions there is a well-developed entrepreneurial fabric associated to this industry both in the aspect of the manufacturing of cells as well as like investors and trackers. One can say that in the Region of Murcia there is implantation of the sector of solar trackers, but at a very low level.

The position of Murcia within the ranking in Spain in installed wind power is the thirteenth position as can be seen from Fig. 10. Until the year 2000 Murcia had been in the last positions in installed wind power capacity (data not shown), today this capacity has increased considerably, but the region continues to occupy a low position when compared to other regions.

Similar to what has already been commented with regard to the case of photovoltaic energy, a disparity between regions exists as to the capacity installed, which is difficult to explain. As can be seen Castilla la Mancha, Castilla León and Galicia lead the field in capacity installed and with a great difference over the remainder. If we consult the potentials of wind power in Spain [25], the greatest potentials are reached in the Valle del Ebro (9.5 m/s), the coast of Galicia (9.0 m/s) and the eastern zone of Castilla La Mancha (7.0 m/s). In the case of Galicia technological companies have been based there for many years, which may justify its high development. With regard to Castilla y León the justification for the high amount of installed capacity may be due to the forecasts of electricity distribution infrastructure planned by the Spanish Electricity Grid (*Red Eléctrica Española*-REE), which connect this with Galicia.

The interest for this energy must be considered which in 2007 reached peaks of generation of wind power up to 13606 MW, consolidating Spain as the second power in Europe, which to be adequately exploited must go hand in hand with a good distribution network.

The problems surrounding the exploitation of the water resources of the Region of Murcia have already been commented above and these are reflected in the comparative with the values for Spain (Fig. 11), where Murcia occupies the 15th position in the ranking of Spain.

With regard to the values for other regions in this case it is easy to infer the great distance that exists from the wet Spain to the dry Spain. Thus the greater values for Galicia are produced by its elevated precipitation rate, and those of Aragón, Castilla La Mancha, Castilla León, Cataluña and Andalucía by the major drainage basins therein.

The value of capacity installed in the Region of Murcia with respect to the production of energy from biogas puts the region in 11th position (Fig. 12).

The greatest values obtained correspond to those regions with a greater population, since their waste treatment plants have a sufficiently large volume so as to make the biogas installations profitable. This is the source of biogas which is in a technologically better position to be exploited. With regard to rural sources, these are greater in regions such as Murcia—decentralisation and competition from thermal drying and composting prevent reaching higher values.

5. Conclusions

The institutions, associations and organisms linked to RE in Spain affirm that this country is one of the greatest powers in the

world in said energies. In 2006, the market for RE in Spain generated a turnover of €2816 M and the forecast of the PER [1] is that the market will generate €21000 M until 2010. Moreover, it is a market which has until the same year, 2006, employed 180000 people [26].

These data allow to affirm that the market of renewable energies is one of the fastest growing markets in recent years in Spain and it is key to the energy policies and for employment at national level.

When taking into account the growth enjoyed by the RE, not all of them have been equally competitive, economically speaking, with respect to conventional energies. In this sense, the wind power installations and the mini hydro-electric power stations with a nominal capacity below 10 MW, have practically reached the threshold of profitability. However, others such as solar photovoltaic or high temperature solar power need strong support which permits the development of the technology and the promotion, when necessary, of demonstration installations. For this, national policies make efforts aimed at making the great majority of RE become competitive in the short or medium term.

The detailed study of the renewable energy sector in the Region of Murcia demonstrates that it is a region with big possibilities, but that for development promotion is necessary from different fields. A great potential in solar photovoltaic energy, in wind power, and in biogas has been shown. Once the potential has been identified then a task of planning and reorganising the objectives established becomes necessary, since in some cases they have already been met and in others they appear difficult to achieve.

With regard to the entrepreneurial sector it should be noted that there is not a major presence of Murcian companies generating technology in the field of renewable energies. The majority of the companies are in the business of energy production, distribution and installation yet depend on external technology. This sector currently finds itself in a situation of a lack of regularisation in professional accreditations and certification of installations, a fact which the business associations demand as a means to value their companies.

This sector is throughout Spain currently pending the resolution of the relevant administrative files, which are usually associated to the requirements of environmental management, and which could be affected in the Region of Murcia by the coming into force in January 2010 of the Law 4/2009 of Integrated Environmental Protection [27]. This fact negatively affects the profitability of the installations which in many cases have been awaiting authorisation for years.

From the administration an approximation to the problems of this sector has been made; such steps have been included in the actions proposed in the Law 10/2006 for Renewable Energies and saving and Energy Efficiency of the Region of Murcia [28], but it should be highlighted that the majority have still yet to come into force. Amongst them one must highlight the recent publication of the Strategy of the Region of Murcia against the Climate Change 2008–2012 [29]. A further theme still pending from the management of the regional administration is the articulation of an accreditation for companies which install or maintain installations. Another is to create an ‘‘Authorisation of Exploitation’’, with the purpose of speeding up the administrative process by uniting all the procedures into a single combined procedure. Another is the creation of an Entity of Energetic Certification at regional level which certifies all the installations which include energy saving, therefore covering the renewable energies installations. This law also recommends the creation of an Office of Technological Transfer.

With reference to the problem that exists surrounding the payment of bonuses, it should be noted that this sector bases its medium term expansion on this type of aid, since the sector must compete with high productivity generation such as for example the natural gas combined-cycle power stations.

The high initial uncertainty of the investment may be mitigated by assuring the purchase of the electricity from renewable sources, until they can be commercially competitive with the fossil energies. Similarly, this initial investment could be reduced if the connection costs were shared between the producing company and the exploiting company.

The solution to the problem of the evacuation and distribution of the energy generated in the region requires complementing the existing evacuation channels with others which would facilitate access to installations situated in the generation zones with the greatest potential.

The development of a technological belt which promotes the impulse of private investment has been of great help in other regions, so the promotion of this sector leads directly to an improvement in the RE, as well as to job creation. Coupled with this, the development of policies to promote applied research in this field would favour the installation of these companies in the region. Similarly, the search for solutions to the problem of storing the energy should be one of the priorities in the research and development plans in the region, since they make the synchronisation between generation and consumption profitable.

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